HOCHSCHULE RHEIN-WAAL
&
FLUXANA GMBH & CO. KG

BACHELOR'S THESIS

Development of an automated powder dosing system using a 6-DOF collaborative robotic arm (cobot)

by investigating the influence of vibration, angle of dosing, and rotational speed to the mass flow of the powder.

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Declaration of Authorship

I, Abdelrahman MOSTAFA, declare that this thesis titled, "Development of an automated powder dosing system using a 6-DOF collaborative robotic arm (cobot)" and the work presented in it are my own. I confirm that:

- This work was done wholly or mainly while in candidature for a research degree at this University.
- Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated.
- Where I have consulted the published work of others, this is always clearly attributed.
- Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work.
- I have acknowledged all main sources of help.
- Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.

Signed:

Date:

"Thanks to my solid academic training, today I can write hundreds of words on virtually any topic without possessing a shred of information, which is how I got a good job in journalism."

Dave Barry

HOCHSCHULE RHEIN-WAAL

Abstract

Faculty of Technology & Bionics
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Bachelor of Science

Development of an automated powder dosing system using a 6-DOF collaborative robotic arm (cobot)

by Abdelrahman MOSTAFA

The Thesis Abstract is written here (and usually kept to just this page). The page is kept centered vertically so can expand into the blank space above the title too…

Acknowledgements

The acknowledgments and the people to thank go here, don't forget to include your project advisor…

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1.1 Motivation

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1.3 Thesis Structure

Chapters – this is the folder where you put the thesis chapters. A thesis usually has about six chapters, though there is no hard rule on this. Each chapter should go in its own separate `.tex` file and they can be split as:

- Chapter 1: Introduction to the thesis topic
- Chapter 2: Background information and theory
- Chapter 3: (Laboratory) experimental setup
- Chapter 4: Details of experiment 1
- Chapter 5: Details of experiment 2
- Chapter 6: Discussion of the experimental results
- Chapter 7: Conclusion and future directions

This chapter layout is specialised for the experimental sciences, your discipline may be different.

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Part I

Basics of Robotics, ROS, and Powder Dosage

Chapter 2

Basics of Robotics

As an academic field, robotics emerges as a relatively youthful discipline, characterized by profoundly ambitious objectives, the most paramount of which is the creation of machines capable of emulating human behavior and cognitive processes. This quest to engineer intelligent machines inherently compels us to embark on a journey of self-exploration. It prompts us to scrutinize the intricacies of our own design—why our bodies possess the configurations they do, how our limbs synchronize in movement, and the mechanisms behind our acquisition and execution of intricate tasks. The realization that the fundamental inquiries in robotics are intrinsically linked to inquiries about our own existence forms a captivating and immersive aspect of the robotics pursuit. [9]

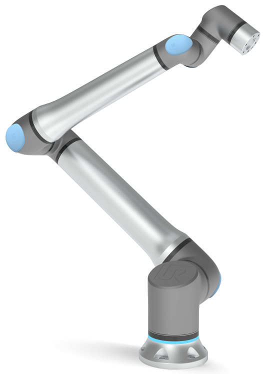
Robotics is the scientific field dedicated to the study of robots—machines capable of autonomous operation, carrying out various tasks without direct human intervention. While science fiction often envisions robots in humanoid or android forms, real-world robots, especially those designed for industrial applications, typically deviate from human physical resemblance. These robots typically comprise three fundamental components: a mechanical structure, often represented by a robotic arm, enabling physical interaction with the robot's environment or itself; sensors that collect data on various physical attributes such as sound, temperature, motion, and pressure; and a processing system that interprets data from the robot's sensors, providing instructions for task execution.
It's worth noting that certain devices, like web-crawling search engine bots that systematically explore the internet to collect information on links and online content, may lack physical mechanical elements. Nonetheless, they are still classified as robots because they exhibit the ability to perform repetitive tasks autonomously.

This chapter delves into an exploration of various robot classifications, delving into the foundational principles of mechanics and kinematics. It also scrutinizes the intricacies of planning and control within the context of collaborative robots (cobots).

2.1 Types of Robots

Across diverse industries, robotics solutions have emerged as catalysts for heightened productivity, elevated safety standards, and increased operational adaptability. Organizations at the vanguard of innovation are discerning forward-looking applications of robotics that yield palpable and quantifiable outcomes. Intel collaborates closely with manufacturers, system integrators, and end-users, actively contributing to the realization of robots that deliver impactful, human-centered results.

(a) NASA Robonaut [1] [2]



(b) Universal Robot (UR20) [19]

FIGURE 2.1: Figure a is an example of a humanoid robot created by Nasa, whereas b is an example of a cobot

According to an article from Intel regarding the classification of robots [7], the current generation of robots has been categorized into six distinct groups.

Autonomous Mobile Robots (AMRs) [4] AMRs navigate their environments and make rapid decisions on the fly. These robots employ advanced technologies like sensors and cameras to gather data from their surroundings. Equipped with onboard processing capabilities, they analyze this data and make well-informed decisions—whether it involves avoiding an approaching human worker, selecting the exact parcel to pick, or determining the suitable surface for disinfection. These robots are self-sufficient mobile solutions that operate with minimal human intervention. [14]

Automated Guided Vehicles (AGVs) [20] While AMRs navigate their surroundings autonomously, AGVs typically operate along fixed tracks or predetermined paths and frequently necessitate human supervision. AGVs find extensive application in scenarios involving the transportation of materials and goods within controlled settings like warehouses and manufacturing facilities.

Humanoids [8] While numerous mobile humanoid robots could, in a technical sense, be classified as Autonomous Mobile Robots (AMRs), this categorization primarily applies to robots fulfilling human-centric roles, frequently adopting human-like appearances. These robots leverage a similar array of technological components as AMRs to perceive, strategize, and execute tasks, encompassing activities such as offering navigational assistance or providing concierge services.

Hybrids [17] Diverse categories of robots are frequently integrated to engineer hybrid solutions that possess the capacity to execute intricate operations. For instance, the fusion of an AMR with a robotic arm can yield a versatile system tailored for the handling of packages within a warehouse environment. As functionalities are amalgamated within single solutions, there is a concurrent consolidation of computational capabilities.

Articulated Robots [16] Commonly referred to as robotic arms, are designed to replicate the versatile functions of the human arm. These systems typically incorporate a range of rotary joints, varying from two to as many as ten. The inclusion of additional joints or axes equips these robotic arms with a wider range of motion capabilities, rendering them particularly well-suited for tasks such as arc welding, material manipulation, machine operation, and packaging.

Cobots [12] Collaborative Robots, commonly referred to as cobots, are engineered with the specific purpose of working in tandem with, or directly alongside, human operators. Unlike many other categories of robots that function autonomously or within strictly segregated workspaces, cobots share work environments with human personnel to enhance their collective productivity. Their primary role often involves the removal of manual, hazardous, or physically demanding tasks from daily operations. In certain scenarios, cobots are capable of responding to and learning from human movements, further enhancing their adaptability.

The initial four robots fall under the category of mobile robots, possessing the capability to navigate within their surroundings, while the latter two are categorized as stationary robots, as detailed in table 2.1 below.

TABLE 2.1: Robots Classification.

Mobile	**Stationary**
AMRs	
AGVs	Articulated robots
Humanoids	**Cobots**
Hybrids	

Within the scope of this paper, our exclusive focus will be on **cobots** [12]. Across all the experiments conducted in this study, a cobot (Ned2, detailed and described in chapter 5) has been consistently utilized.

2.2 Robotic Arm Kinematics

2.3 Robot Control (Software)

Chapter 3

Robot Operating System | ROS

3.1 Linux for Robotics

3.1.1 What Is Ubuntu? and Why for Robotics?

3.2 Philosophy Behind ROS

The philosophical objectives of ROS can be succinctly described as follows [13]:

- Decentralized collaboration: Emphasizing peer-to-peer interactions.
- Tool-oriented approach: Focusing on the development of a robust set of tools.
- Multilingual support: Enabling compatibility with multiple programming languages.
- Thin design: Prioritizing a streamlined framework.
- Openness and freedom: Being freely available and based on open-source principles.

To the best of our knowledge, no existing framework encompasses this specific set of design principles. This section aims to delve into these philosophies, elucidating how they have profoundly influenced the design and implementation of ROS [13].

3.3 Preliminaries

3.3.1 ROS-Graph

3.3.2 Roscore

3.3.3 catkin, Workspaces, and ROS Packages

3.4 ROS Communication

3.4.1 Publishers-Subscribers

3.4.2 Services

3.4.3 Actions

3.5 MoveIt! [18]

MoveIt![3] serves as the primary software framework within the Robot Operating System (ROS) for motion planning and mobile manipulation. It has garnered acclaim for its seamless integration with various robotic platforms, including the PR2

[21], Robonaut [1], and DARPA's Atlas robot. MoveIt! is primarily coded in C++, augmented by Python bindings to facilitate higher-level scripting. Embracing the fundamental principle of software reuse, advocated for in the realm of robotics [10], MoveIt! adopts an agnostic approach towards robotic frameworks, such as ROS. This approach entails a formal separation between its core functionality and framework-specific elements, ensuring flexibility and adaptability, especially in inter-component communication.

By default, MoveIt! leverages the core ROS build and messaging systems. To facilitate effortless component swapping, MoveIt! extensively employs plugins across its functionality spectrum. This includes motion planning plugins (currently utilizing OMPL), collision detection (presently incorporating the Fast Collision Library (FCL) [11]), and kinematics plugins (employing the OROCOS Kinematics and Dynamics Library (KDL) [15] for both forward and inverse kinematics, accommodating generic arms alongside custom plugins).

MoveIt!'s principal application domain lies in manipulation, encompassing both stationary and mobile scenarios, across industrial, commercial, and research settings. For a more comprehensive exploration of MoveIt!, interested readers are encouraged to refer to **Cite here**.

Chapter 4

Basics of Powder Dosing

4.1 Affecting Parameters

Part II

Experimental Set-up, Methodology, and Results

Chapter 5

Experimental Set-up

This chapter initiates a comprehensive exploration of the experimental setup. It commences with an overview of the workspace frame, encompassing the array of interconnected devices. These include various crucibles, the balance device, both its hardware and software components, the Ned2-cobot with its hardware configurations and software tools, precision validation procedures and concludes with an examination of the vibration motor, which is an auxiliary component integrated with the cobot.

5.1 Frame

5.2 Crucibles

5.3 Balance

5.3.1 Hardware

5.3.2 Software

5.4 Ned2 Collaborative Robot

Ned2 is a collaborative robot, often referred to as a cobot, developed by the French company Niryo [5]. This particular cobot has been purpose-built for educational and research applications, serving as a valuable tool for the development of proof of concepts and experimental work. In the context of this research, the Ned2 cobot played a pivotal role in conducting experiments.

The forthcoming sections delve into an in-depth examination of the hardware specifications and software options offered by the Ned2 cobot.

5.4.1 Hardware Configurations

Ned2 is a six-axis collaborative robot, based on open-source technologies. It is intended for education, research and Industry 4.0." [6]

Incorporating the same aluminum framework as its predecessor, Ned2 maintains its commitment to meeting your exacting standards in terms of durability, precision, and repeatability (with an accuracy, and a repeatability of 0.5 mm).

Ned2 operates on the Ubuntu 18.04 platform and utilizes the ROS Melodic framework, capitalizing on the capabilities of the **Raspberry Pi 4**. This high-performance **64-bit ARM V8 processor**, coupled with **4GB of RAM**, empowers Ned2 to deliver enhanced performance.

This iteration of Ned2 introduces advanced servo motors equipped with Silent Stepper Technology, significantly reducing the operational noise of the robot.

The technical specifications of Ned2 are described as shown in ...... table below.

5.4.2 Software Tools

Ned2 represents a collaborative robot, hinging on the Ubuntu 18.04 platform and ROS (Robot Operating System) Melodic—a widely adopted open-source solution in the field of robotics. Leveraging ROS, Ned2 offers an extensive array of libraries that empower users to create a wide spectrum of programs, from the simplest to the most intricate, thus ensuring adaptability to diverse operational requirements. [6]

5.5 Precision Validation

5.6 Vibration Motor

Chapter 6

Methodology

6.1 Sequence Logic

6.2 Each State of the State Diagram

Chapter 7

Evaluation & Results

7.1 Evaluation

Chapter 8

Conclusion & Future Work

small description of what I have done.. What are my final findings and thoughts...

The future work, what to come.

8.1 Future Work

Appendix A

Frequently Asked Questions

A.1 How do I change the colors of links?

The color of links can be changed to your liking using:
`\hypersetup{urlcolor=red}`, or
`\hypersetup{citecolor=green}`, or
`\hypersetup{allcolor=blue}`.
If you want to completely hide the links, you can use:
`\hypersetup{allcolors=.}`, or even better:
`\hypersetup{hidelinks}`.
If you want to have obvious links in the PDF but not the printed text, use:
`\hypersetup{colorlinks=false}`.

Appendix B

FX_ROS.py Library in Python

```python
#!/usr/bin/env python
import tf
import time
import sys

import numpy as np
import matplotlib.pyplot as plt

import rospy
#from ActionClient import ActionClient
from sensor_msgs.msg import JointState
from niryo_robot_arm_commander.srv import GetFK, GetFKRequest, GetJointLimits, JogShift, JogShiftRequest, JogShiftResponse
#from niryo_robot_msgs.srv import SetBool, SetBoolRequest, SetInt, SetIntRequest, Trigger

#from niryo_robot_arm_commander.msg import ArmMoveCommand, RobotMoveGoal, RobotMoveAction

from moveit_msgs.srv import GetPositionFK, GetPositionIK

from std_msgs.msg import Header
from moveit_msgs.msg import RobotState as RobotStateMoveIt

from geometry_msgs.msg import Pose
import geometry_msgs
from niryo_robot_msgs.msg import RobotState
import moveit_commander
import moveit_msgs.msg
import actionlib

#robot = moveit_commander.RobotCommander()
#scene = moveit_commander.PlanningSceneInterface()
#global arm
def Connect_to_arm():
    global arm
    try:
        arm = moveit_commander.move_group.MoveGroupCommander("arm")
    except:
        raise RuntimeError

def Call_Aservice(service_name, type, request_name=None, req_args=None):
    """Call a ROS service.

    Parameters:
    ........................
    service_name: str
    type: srv
```

```
    request_name: None (srv)
    req_args: None (dictionary) ex. {'positon': 210, 'id': 11, 'value': False}
    should_return ?: None (int) >> is set to 1, if you want to return the response of the service.

    Returns:
    ........................
    If should_return is set to 1, the function is going to return the response of the service.
    Otherwise, the function should only call the service to do a certain action with no return.
    """
    try:
        rospy.wait_for_service(service_name, 2)
    except (rospy.ServiceException, rospy.ROSException) as e:
        rospy.logerr("Timeout and the Service was not available : " + str(e))
        return RobotState()

    try:
        service_call = rospy.ServiceProxy(service_name, type)

        if request_name == None:
            response = service_call()
        else:
            request = request_name()
            for key, value in req_args.items():
                #print("f{key} = {value}")
                method = setattr(request, key, value)
            response = service_call(request)

    except rospy.ServiceException as e:
        rospy.logerr("Falied to call the Service: " + str(e))
        return 0

    return response

def Subscribe(topic_name, type, msg_args):
    """Subscribe to a certain topic.

    Parameters:
    ........................
    topic_name: str
    type: srv
    msg_args: list >> list of strings, which contains the arguments that we need to read from the topic.

    Returns:
    ........................
    Return a list of the read values from each argument.
    If we have only one argument, it returns the value of this argument only, not a list.
    """

    #rospy.init_node('FX_ROS_Subscriber')

    try:
        msg = rospy.wait_for_message(topic_name, type, 2)
    except:
        rospy.logerr("Timeout and the Topic Did not recieve any messages")
        return 0
```

```


    value = []

    if len(msg_args) == 1:
        value = getattr(msg, msg_args[0])
    else:
        for i in msg_args:
            value.append(getattr(msg, i))

    return value

def Get_joints():
    """return a tuple of 6 values for each joint from 1 till 6"""

    joints_values = Subscribe('/joint_states', JointState, ["position"
    ])

    return joints_values

def get_pose():
    """Gets the pose values from the robot_state topic.
    Return:
    ..................................
    a list of two dictionaries, the first is positions (x,y,z),
    whereas the second is the rpy (roll, pitch, yaw)
    """

    return Subscribe('/niryo_robot/robot_state', RobotState, ['position
    ', 'rpy'])

def get_pose_list():
    """Use get_pose() function to get the pose, and turn it into a list
    .
    Return:
    ............................
    A list of floats >>> [x, y, z, roll, pitch, yaw]
    """

    pose = get_pose()
    position = pose[0]
    rpy = pose[1]

    return [position.x, position.y, position.z, rpy.roll, rpy.pitch,
    rpy.yaw]

def Get_FK_Niryo(joints):
    """Give the the joints' values to the forward kinematics service
    provided by Niryo, and get the pose coordinations.
    """
    fk_service = '/niryo_robot/kinematics/forward'
    return Call_Aservice(fk_service, GetFK, GetFKRequest, {'joints':
    joints}, should_return=1).pose

def FK_Moveit(joints):
    """Get Forward Kinematics from the MoveIt service directly after
    giving joints
    :param  joints
    :type   joints: list of joints values
    :return: A Pose state object
    @example of a return

position:
```

```
  x: 0.278076372862
  y: 0.101870353599
  z: 0.425462888681
orientation:
  x: 0.0257527874589
  y: 0.0122083384395
  z: 0.175399274203
  w: 0.984084775322

    """
    rospy.wait_for_service('compute_fk', 2)
    moveit_fk = rospy.ServiceProxy('compute_fk', GetPositionFK)

    fk_link = ['base_link', 'tool_link']
    header = Header(0, rospy.Time.now(), "world")
    rs = RobotStateMoveIt()

    rs.joint_state.name = ['joint_1', 'joint_2', 'joint_3', 'joint_4',
    'joint_5', 'joint_6']
    rs.joint_state.position = joints

    reponse = moveit_fk(header, fk_link, rs)

    return reponse.pose_stamped[1].pose


def Jog_shift(joints_or_pose, axis, value):
    """Use the service jog_shift_commander to shift one axis.
    Paramters:
    ........................
    joints_or_pose: int >>> 1 for joints_shift, and 2 for pose_shift
    axis: int >>> (1,2,3,4,5,6) = (x,y,z,roll,pitch,yaw)
    value: float >> the value for which you want to shift the Jog axis.

    Returns: None
    ........................
    """

    axis -= 1
    name = "/niryo_robot/jog_interface/jog_shift_commander"
    shift_values = [0, 0, 0, 0, 0, 0]
    shift_values[axis] = value

    req_arg = {'cmd': joints_or_pose, 'shift_values': shift_values}

    Call_Aservice(name, JogShift, JogShiftRequest, req_arg)

def Move_pose_axis(axis, new=None, add=None, arm_speed=None):
    """You should either put a value to add or new, not both.

    Parameters:
    ........................
    * axis: str -> (x, y, z, roll, pitch, or yaw)
    * new: float -> The new coordination you want to give to a certain
    axis.
           "new" will always overwrite the value of the axis.
    * add: float -> the value in meters or radians you want to add to a
     certain axis.
    * arm_speed: float (optional) -> between 0 and 1. (0,1]
    Returns: None
    ........................
    """
    FK = get_pose()
```

```
    axises = ['x','y','z']

    pose = Pose()
    p_goal = pose.position
    orn_goal = pose.orientation

    p_current = FK[0]

    rpy_current = FK[1]

    if add:
        if axis.lower() in axises:
            current_value = getattr(p_current, axis)
            setattr(p_current, axis, current_value+add)
        else:
            current_value = getattr(rpy_current, axis)
            setattr(rpy_current, axis, current_value+add)
    if new:
        if axis.lower() in axises:
            setattr(p_current, axis, new)
        else:
            setattr(rpy_current, axis, new)


    p_goal.x = p_current.x
    p_goal.y = p_current.y
    p_goal.z = p_current.z

    orn_goal.x, orn_goal.y, orn_goal.z, orn_goal.w = tf.transformations
    .quaternion_from_euler(rpy_current.roll,rpy_current.pitch,
    rpy_current.yaw)

    arm.set_pose_target(pose)

    if arm_speed:
        set_speed(arm_speed)
    arm.go(wait=True)

    arm.stop()
    arm.clear_pose_targets()

def Move_to_pose(pose_values, arm_speed=None):
    """Move to a given pose values.
    Parameters:
    ........................

    pose_values: list or tuble -> [x, y, z, roll, pitch, yaw]
    arm_speed: float (optional) -> between 0 and 1. (0,1]
    """

    pose = Pose()
    p_goal = pose.position
    orn_goal = pose.orientation

    p_goal.x = pose_values[0]
    p_goal.y = pose_values[1]
    p_goal.z = pose_values[2]

    roll = pose_values[3]
    pitch = pose_values[4]
    yaw  = pose_values[5]

```

```
    orn_goal.x, orn_goal.y, orn_goal.z, orn_goal.w = tf.transformations
    .quaternion_from_euler(roll,pitch,yaw)

    #arm.set_goal_tolerance(0.001)
    if arm_speed:
        set_speed(arm_speed)
    arm.set_pose_target(pose)
    arm.go(wait=True)

    arm.stop()
    arm.clear_pose_targets()

def move_to_joints(joints, arm_speed=None):
    """Move to a given joint values.
    Parameters:
    ........................

    joints: list or tuble -> [joint1, joint2, joint3, joint4, joint5,
    joint6]
    arm_speed: float (optional) -> between 0 and 1. (0,1]
    """
    joints_limits = Get_Joints_limits()

    for i in range(6):
        if joints_limits.joint_limits[i].max < joints[i] or joints[i] <
     joints_limits.joint_limits[i].min:
            print("Joint{} = {}, which is out of limit!".format(i+1,
    joints[i]))
            print("Joint{} can not be more than {} neither less than {}
    ".format(i+1, joints_limits.joint_limits[i].max, joints_limits.
    joint_limits[i].min))
            return
        else:
            pass

    #arm.set_joint_value_target(joints)
    if arm_speed:
        set_speed(arm_speed)
    arm.go(joints, wait=True)

    arm.stop()

def Move_joint_axis(axis, new=None, add=None, arm_speed=None):
    """You should either put a value to add or new, not both.

    Parameters:
    ........................
    * axis: int -> the number of the joint that you want to move

    * new: float -> The new coordination you want to give to a joint (
    axis).
              "new" will always overright the value of the axis.
    * add: float -> the value in meters change in a certain joint (axis
    ).
    * arm_speed: float (optional) -> between 0 and 1. (0,1]

    Returns: None
    ........................
    """
    moving_joints = list(Get_joints())

    if new:
        moving_joints[axis-1] = new
```

```
    elif add:
        moving_joints[axis-1] += add

    joints_limits = Get_Joints_limits()

    if joints_limits.joint_limits[axis-1].max < moving_joints[axis-1] or moving_joints[axis-1] < joints_limits.joint_limits[axis-1].min:
        print("The joint{} can not be more than {} neither less than {}".format(axis, joints_limits.joint_limits[axis-1].max, joints_limits.joint_limits[axis-1].min))
        return 0
    else:
        pass

    arm.set_joint_value_target(moving_joints)
    if arm_speed:
        set_speed(arm_speed)
    arm.go(moving_joints, wait=True)

    arm.stop()

def Get_Joints_limits():
    """Getting the limits for each joint.

    You can get any joint limits as following:

    Get_Joints_limits().joint_limits[0 - 5].max (float)
    Get_Joints_limits().joint_limits[0 - 5].min (float)
    Get_Joints_limits().joint_limits[0 - 5].name (str)

    Where 0 for (joint 1), and 5 for (joint 6)
    max, min, or name would give the maximum, minimum, or name of the indicated joint.
    """

    joints_limits = Call_Aservice('/niryo_robot_arm_commander/get_joints_limit', GetJointLimits)
    return joints_limits

def set_speed(speed):
    """Set a scaling factor for optionally reducing the maximum joint velocity. Allowed values are in (0,1]."""
    arm.set_max_velocity_scaling_factor(speed)

def wait(duration):
    """wait for a certain time.

    :param duration: duration in seconds
    :type duration: float
    :rtype: None
    """
    time.sleep(duration)

def move_with_action(pose):
    """Still under development"""

    moveit_commander.roscpp_initialize(sys.argv)
    rospy.init_node('simple_action', anonymous=True)

    robot_arm = moveit_commander.move_group.MoveGroupCommander("arm")

    robot_client = actionlib.SimpleActionClient('execute_trajectory', moveit_msgs.msg.ExecuteTrajectoryAction)
```

```
    robot_client.wait_for_server()
    #rospy.loginfo('Execute Trajectory server is available for robot')

    robot_arm.set_pose_target(pose)
    #robot_arm.set_pose_target([0.29537095654868956, 4.675568598554573e
    -05, 0.4286678926923855, 0.0017192879795506913,
    0.0014037282477544944, 0.0001612035813676269 3])
    robot_plan_home = robot_arm.plan()

    robot_goal = moveit_msgs.msg.ExecuteTrajectoryGoal()
    robot_goal.trajectory = robot_plan_home

    robot_client.send_goal(robot_goal)
    robot_client.wait_for_result()
    robot_arm.stop()

def move_pose_orn(pose, arm_speed=None):
    """Move to a given pose values, but with orientation not rpy.

    Parameters:
    ........................
    * pose: A Pose state object

example of the pose state object that should be given:
    ========================
    position:
        x: 0.278076372862
        y: 0.101870353599
        z: 0.425462888681
    orientation:
        x: 0.0257527874589
        y: 0.0122083384395
        z: 0.175399274203
        w: 0.984084775322
    ========================
    """

    arm.set_pose_target(pose)
    if arm_speed:
        set_speed(arm_speed)
    arm.go(wait=True)

    arm.stop()
    arm.clear_pose_targets()

def move_to_named_pos(position_name, arm_speed=None):
    """Avalible names:
    - 'resting'
    - 'straight_forward'
    - 'straight_up'
    """
    arm.set_named_target(position_name)
    if arm_speed:
        set_speed(arm_speed)
    arm.go(wait=True)
```

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